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Nicky Priaulx
Cardiff University, priaulxn@cardiff.ac.uk

Martin Weinelm
Cardiff University, weinelm@cardiff.ac.uk

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NICKY PRIAULX & MARTIN WEINEL

Reader in Law
Cardiff Law School
Cardiff University
Museum Avenue
Cardiff, Wales CF10 3AX
Priaulxn@cardiff.ac.uk

Research Associate, IMGAME
School of Social Sciences
Cardiff University
Glamorgan Building
King Edward VII Avenue
Cardiff, Wales CF10 3WT
Weinelm@cardiff.ac.uk

ABSTRACT: Focusing on the intersection between law and science, we argue that the skills of sociological discrimination constitute a critical and foundational skill-set for meaningful science comprehension in enabling audiences to make better sense of and take a critical/ informed stance to scientific knowledge and policy.

KEYWORDS: lawyers, law, understanding, science, sociological discrimination.

1. INTRODUCTION: THE PURPOSES OF COMMUNICATIONS OF SCIENCE AND SCIENCE COMMUNICATION

Beyond the most abstract conceptualization, science communication admits of no single purpose. For one, not all communications *of* science are necessarily assigned an explicit purpose which aligns with the rationality of "Science Communications" (SciComms) as a growing field of concern. Many communications of science could speak to a more traditional conception of the general good of citizens being more "educated" and the desirability of having greater access to information about the world around them. In this sense, "communicating science" can describe something totally general, a wide range of activities, media, and public forums, such as museums, which have occurred across many generations, which have long put science on "show" and fed in some aspects of science into the public realm. Yet while the communication of science is clearly not a novel phenomenon, what is distinctive so as to constitute a science communications "field" is the emergence of a conscious effort to communicate more effectively with members of the public. As such, SciComms departs from a communications *of* science approach by virtue of being underpinned by a strong normative agenda which seeks to rationalize how to effectively engage the public with science and how to overcome the quite considerable challenges this involves. In part this would seem to be driven by the urgency of environmental issues, the ethical implications of scientific and technical innovation, and by a belief in the necessity of linking the public with science as a necessity given its central importance to democratic governance and social well-being. Where this normative character can be discerned, it admits of multiple and sometimes nebulous

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aspirations, non-exhaustively, from partly addressing the disequilibrium of expertise between scientists/science communicators and laypersons, for increasing the social accountability of scientists, tapping into new funding streams, furthering robust social policy development, developing an informed public, increasing scientific literacy, persuading publics as to the value and importance of science, and increasing democratic debate in matters of science and technology policy. Moreover, nor can one neglect to consider other aspirations for science communication which can admit of less positive aspirations, for example, dissuading publics as to the value and importance of particular science to promote corporate generation of profit or problematizing accepted science on the basis of "junk science" to sell newspapers or win legal cases. These too, count as communications of science, even if they are ones which make a SciComms agenda that much more difficult and pressing. In furtherance of these aims, or sometimes in the name of a SciComms agenda, we are witness to an ever-increasing range of opportunities for discussing topical scientific issues in a more accessible and informal way from workshops and outreach events, to deliberative forums such as citizens' juries to "popular science" in the form of broader media, including TV, blogs, interactive websites, popular science magazines, and other literatures which synthesize and make accessible aspects of field-specific research work. In this latter respect, notable manifestations of this growth market include the evermore voluminous range of popular science books targeting the public at large, including, for example, the litany of behavioral science works such as *Nudge* (Thaler & Sunstein, 2009), *Freakonomics* (Levitt, 2007), *Predictably Irrational* (Ariely, 2008) and *Switch* (C. Heath & D. Heath, 2011). Many of these have proved extremely successful in being consumed not only by the "public at large" but by more specific audiences, such as lawyers (Frerichs, 2011), policy makers, and politicians (McSmith, 2010).

While the vast range of events and media collectively constitute communications of science, the broad variety of actors involved in the delivery of that media, coupled with considerable pluralism in why a specific science communiction is important, creates significant obstacles to defining an overarching "purpose" that binds these diverse activities together. Typical conceptualizations, which endeavor to bundle up SciComms, point toward particular aspirations, such as "understanding"; for example, the dominant model that formed the main rationalization of early SciComms as a field, was the "transmission" model—a top-down Public Understanding of Science (PUS) approach, where particular importance was placed upon scientists explaining their work to the public (Dean, 2009). Inevitably, such an approach, which continues to define much of existing science communication activity, is replete with challenges, including how to increase the appetite or effectiveness of scientists in transmitting science to public domains, how to communicate the benefits of basic science where, for example, research focused on disease does not immediately translate into effective treatments, or how to tailor "science" so as to speak to different audiences with different "needs and knowledges" ("Lost," 2004, p. 1281). Awareness amongst STS and science communicator scholars that such activities entail a potentially new skill set and range of capabilities has led to a critical literature directed at evaluating the kinds of skills and support scientists need in order to permit them to become better science communicators (Lewenstein & Baram-Tsabari, 2013). Over the last decade, there has also been a growing awareness of the importance of a more dialogical approach, a Public Engagement with Science and Technology (PEST) model which moves away from the "transmission" (or deficit) model toward a focus on deliberative contexts in which publics are directly engaged in a dialogue about science and technology *policy*. Insofar as this approach has led to a range of initiatives designed to directly engage

stakeholders in deliberative forums, which are viewed as having benefits for those engaged in the exercise, these approaches in practice are regarded as resource intensive, typically small in scale and scope, and drawing in publics who are "already opinion intense, well-informed and emotionally committed to an issue" (Nisbet & Scheufele, 2009, p. 1770). As such, deliberative models need to be informed by SciComms research which helps to target broader "inattentive," disinterested audiences as well as a closer examination of the extent to which such deliberative forums and the broader structures which create them are genuinely directed toward making the voices of public actors matter. Nevertheless, while these two approaches, top-down and dialogical, admit of different ways of envisaging the public, from an epistemic perspective, the range of activities and emphases occuring within these domains (delivery of basic science to increase scientific literacy to engaging the public in scientific policy discussion) do not straightforwardly point toward a singular conception of "understanding" or "engagement." Rather, as Dahlstrom and Ho have recently noted, science communication as revealed through techniques of PUS and PEST fails to admit of a clear purpose; as they assess in the context of "narrative approaches," these may admit of techniques of "persuasion" or "comprehension." As they comment, it is possible that,

> [T]he increased prevalence and prominence of science within political controversies may be recent enough that the public and policy makers do not yet have clearly defined expectations of science communication within policy. (Dahlstrom & Ho, 2012, p. 610)

Nevertheless, what might make harder the task of defining a purpose for science communication is the focus on the mass of stuff that differentially envisages "purpose". Different forms and modes of communicating science are shaped by distinctive social, political, economic and historical contexts which can subtly change the character of what is meant by the largely abstract vessels of "scientific literacy," "understanding," or "engagement". All of these conceptions arguably can mean different things depending on who communicates; moreover, ideas of "understanding" or "engagement" will mean different things in the context of a science communication "audience" that is host to significant variance in need, scientific literacy and degrees of practical engagement with science and technology policy. As such, amidst this it may be unsurprising that aspirations for science communication shift between different ideals in the context of an agenda that envisages the very broadest target, with a range of aspired exchanges in mind, between "science" and the "public at large."

Irrespective of the absence of clearly defined expectations of science communication from a political or policy stance, SciComms as a field can play a critical role in advocating for a particular standard and a common starting point for science communications as a whole. As we discuss in the next section, whether the aim is to persuade the public or generate an understanding of science, a common starting point for all communications of science should centralize the basic tools needed to facilitate an informed comprehending or indeed, persuadable public. We seek to operationalize this by bringing to the fore a very specific non-scientific section of public for whom a stronger appreciation of science is not only desirable, but critical. Here we highlight the legal profession as a large but nevertheless largely ignorant consumer of science. As we argue, SciComms aspirations for communications *of* science will be better enhanced through an understanding of the "nature of science," rather than the delivery of substantive/basic science or science "facts," or through engaging publics in the politics of persuasion or attempting to engender basic trust in science. Such approaches in our view do not provide social actors with enough intellectual resources by which to endow them

with the skills to become informed consumers of science or scientific policy. In the absence of a broader scientific aptitude, which provides basic skills in appreciating the nature of scientific knowledge, actors will have few intellectual resources by which to (a) make sense of substantive science; and (b) weigh in the balance competing discourses, including "science" based upon manufactured scientific controversy. As such, our aim here is to provide a case for scientific literacy as consisting of the skills of sociological discrimination and to the widest audience possible.

2. LAWYERS' UNDERSTANDING OF SCIENCE

Undoubtedly central to the success of many science communication efforts is the care taken to make "science" accessible and in one sense "understandable." Yet hidden behind those science communication efforts, when communicated from scientific experts to "non-scientific" audiences, sits a staggering body of scientific work which communicators will have gone to some effort to synthesise and critically *translate* to make communication events presentable and accessible. Take *Nudge* (Thaler & Sunstein, 2009) for example, a book which brought to the popular and political imagination some lab-based insights from behavioral economics and suggested that working with people's psychological tendency towards inertia might result in a reduction in hard regulatory regimes, as well as offering significant benefits for our health, wealth and happiness. The expertise of *Nudge*'s authors and team of research assistants, coupled with their conscious effort to make it appeal to the broadest audience, means that a good deal of the "science" behind *Nudge* can and must fade out of view. Behind the scenes will sit a long and arduous process of rooting out what science to include or not. In this latter regard, the *Nudge* team inevitably will have filtered out those scientific papers viewed as unreliable, being based upon an inappropriate research design, for yielding inconsistent results, for having insufficient controls, being contradicted by later research,[1] for being retracted, or even exposed as fraudulent.[2] A broad range of considerations needs to attend a systematic review of the literature in determining the validity, results and relevance of that research before using it—a process Greenhalgh calls "the science of 'trashing' papers" (Greenhalgh, 1997). That is part of science itself—and that's before Thaler and Sunstein get to the job of developing a thesis based on the scientific evidence they have selected. Not all science is equal and not all science is good science. As such, works of the *Nudge* variety can elegantly mask not only what is a bewilderingly large research effort, but also the nature of science.

The nature of science (or "science of science") refers to the processes of evaluating what constitutes reliable knowledge or not. This is a critical step. It is an understanding of science that is generalizable, and reaches well beyond particular "scientific facts" to be able to question the foundations upon which those facts have been arrived at. Even within sub-branches of science, such as medicine and the health sciences, researchers working within those fields are cautioned that the literature is akin to a jungle, "fast growing, full of dead wood, sprinkled with hidden treasure and infested with spiders and snakes" (Morgan, 1986, p.

[1] For example, "16% of the top-cited clinical research articles on postulated effective medical interventions that have been published within the last 15 years have been contradicted by subsequent clinical studies and another 16% have been found to have initially stronger effects than subsequent research" (Ioannnidis, 2005, p.220).

[2] For example, authors may, subsequent to publication of results, discover a problem with research design or equipment which affects their overall conclusions, for citing faulty data, or data may be faked (see further, Marcus & Oransky, 2013).

98). Yet while experts in those fields will have techniques for helping to identify the difference between a snake and a treasure, for others, particularly those not possessed of the "science of science" perspective, science can look deceptively like a walk in the park. For while *Nudge*-like works seem to make mainstream science accessible, not all science appears *in*accessible (even if typical research papers are less "punchy"). Increasingly, much of scientific work is reported in seemingly intelligible language with standardized structures so that they appear fairly readable. However, in situations where a scientific paper may correspond with aspects of our everyday lives, or indeed core concepts and ideas appear to also form the subject of investigation in alternative academic disciplines, science papers may not only seem readable, but comprehensible.

In this latter respect, "happiness" is something that all but the chronically sad will have insight and experience in, even if few of us are in the business of scientifically testing it. For decades hedonic psychologists have been thinking about the puzzles around how happiness is fostered, lost and regained. In shorthand, hedonic psychology might be best labeled "happiness studies" insofar as the dominant measure used in a controversial theory called "hedonic adaption" or more recently, "adaptive preferences," is happiness. In the original 1970s theory, Brickman and Campbell (1971) proposed that while people react to good and bad events, in a short time they return to a position of neutrality. The authors found that because people are goal-seeking in nature and constantly strive to be happy, happiness and unhappiness merely constituted temporary and short-lived reactions to such events (Brickman & Campbell, 1971). In what became a classic piece of research in the field, Brickman and his colleagues sought to provide empirical backing to the theory and from this concluded that lottery winners were not happier than non-winners, and that people with paraplegia were not substantially less happy than those who can walk. As Diener, Lucas, and Schollon (2006) comment, the appeal of the study lay in it not only offering an explanation "for the observation that people appear to be relatively stable in happiness despite changes in fortune" but also in explaining why "people with substantial resources are sometimes no happier than those with few resources and that people with severe problems are sometimes quite happy" (p. 306).

The theory has appeal at intuitive level. If we think of our lives to date, and consider all the good and bad events that have occurred, our joy at getting a new job, our heartache at the loss of a loved one, we'll quickly be able to assess that the strong impact of emotions that we felt at that time wears off (the extent to which they do, however, is another question). We do indeed get used to things, and they may soon become the background in the context of the new exciting events that lie ahead. But, to what extent can this observation be relevant to thinking about scientific understanding or literacy? Of interest here, a paper written by Samuel Bagenstos and Margo Schlanger (2007), two lawyers, sought to apply this theory directly to hedonic damages in the law of tort. What they claimed was that hedonic damages in the United States should not be awarded based on disability. This head of damages seeks to compensate for the limitations on "the injured person's ability to participate in and derive pleasure from the normal activities of daily life, or for the individual's inability to pursue his talents, recreational interests, hobbies or vocations" (Bagenstos & Schlanger, 2007, p. 748). In raising serious concerns about the practice of awarding hedonic damages, the authors placed strong reliance upon hedonic psychology, noting that "disability does not inherently limit enjoyment of life to the degree that these courts suggest. Rather, people who experience disabling injuries tend to adapt to their disabilities" (Bagenstos & Schlanger, 2007, p. 748). Arguing that such damages and the processes of litigation might also be viewed as discriminatory, the authors claimed that

the legal process serves to reinforce stigma around disability in presenting disability "as a tragedy" and "people with disabilities as natural objects of pity" (Bagenstos & Schlanger, 2007, p. 749).

The work is fascinating and initially compelling. In its "science" component it draws upon hedonic psychology to critique aspects of legal policy, and indeed to challenge it. The challenge seems to be motivated by equality concerns and justified by reference to hard science. Moreover, it feeds directly into general anxieties about the extent to which legal policy, and indeed, tort law, fail to correspond to the "real world" (Lewis & Morris, 2012), as well as specific battles over non-pecuniary damages in the US, and the propriety of awarding them (Janutis, 2006; Sgro, 2011). The argument that a significant aspect of non-pecuniary damages over-compensates victims for illusory losses hardly breaks new ground in torts theory;[3] however, what is novel, and begs to be taken more seriously by policy makers and legal academics, is the presentation of new "evidence" that has the weight of science standing behind it. But that for us is *the* question: to what extent do Bagenstos and Schlanger's (2007) recommendation for legal reform warrant serious consideration?

An important starting point is that if the science of hedonic adaptation is not quite what they claim, Bagenstos and Schlanger's (2007) recommendations fail (though we might find the questions their work raises as nevertheless interesting). And critically, the science is not as they present. Rather, the body of research around hedonic adaptation/adaptive preferences is very much "work-in-progress." Of course whilst "normal science" can be typified as a work-in-progress in one important sense, given that science does not produce ultimate "truths" but consists of a project committed to continual revision and refinement, there remains a need for some stable and critical core for a field of science to develop. It is this stable and critical core which hedonic adaptation or adaptive preferences lacks. Fitting Collins and Pinch's (1993) conception of "Golem science," the disputes in this field relate not to the periphery but to the central subject matter. Though Golem science has the potential to become normal science, it has not yet achieved closure to the satisfaction of the core-set. In the context of hedonic adaptation, the field is replete with contradictory results, and diametrically opposing findings as to the extent of adaptation can be found elsewhere (Fuhrer, 1992; Uppal, 2006). Richard Easterlin (2003) notes that "there is a demonstrable tendency in the psychological literature to overstate the extent of adaptation to life events," and that the extent of adaptation to a disabling condition may "vary depending on the personality or other characteristics of the individual affected" (p. 11177). In particular the finding, which seems to be repeated throughout the literature subsequent to Brickman and Campbell's (1971) study, that the assumption of the hedonic treadmill theory, notably that adaption to circumstances occurs in similar ways for all individuals, is simply false. As Diener et al. (2006) found in their longitudinal studies, "the size and even the direction of the chance in life satisfaction varied considerably across individuals" (p. 310). Moreover, one of the key psychological proponents of the "science of happiness," Daniel Kahneman (2009), despite initial enthusiasm for the hedonic adaptation theory, has subsequently noted that,

> Social scientists rarely change their minds, although they often adjust their position to accommodate inconvenient facts. But it is rare for a hypothesis to be so thoroughly falsified. Merely adjusting my

[3] For example, economists have long questioned the propriety of awarding non-pecuniary losses on the basis of a "willingness to pay" to reduce the risk of injury (see further, Sunstein, 2007).

> position would not do; although I still find the idea of an aspiration treadmill attractive, I had to give it up. (p. 197)

There would, as such, seem to be very good reasons shaping why theorists within the field of hedonic psychology would be hesitant in making any claims as to the ubiquity of hedonic adaptation. Diener et al. (2006) have cautioned against putting adaptation theory into practice given the many questions that necessitate researchers' attention (p. 312). Yet, in the face of there being "no clearly established theoretical consensus over why people adapt, at what rate they adapt, when they adapt or not, or what increases or decreases rates of adaptation" (Huang & Swedloff, 2009, p. 574), Bagenstos and Schlanger (2007) (who are lawyers, not psychologists) not only prove to be highly selective in the studies they do include (those which highlight a high level of adaptation), overlooking all of the serious concerns attending hedonic psychology (from experts within the field), but explicitly dismiss even those who argue that the field lacks "conceptual coherence and empirical grounding" on the basis that,

> We take a different tack. We agree with the theory's proponents that adaptive preferences exist and that they raise significant normative questions about the unreflective use of preferences as a measure of justice or a basis for policy. (p. 747)

Quite critically, insofar as these authors present arguments claimed to be justified by reference to the science of adaptive preferences, a closer analysis reveals that the claims are wholly unsupportable (and for broader reasons than have been expressed here; see further, Priaulx, 2012). Key to this is a failure to understand the nature of science and to appreciate how science works. While some interesting points do arise from their analysis, from an epistemic perspective, any legal policy recommendation made by these authors should be ignored for lack of a scientific justification. It may be of course, that policy makers may nevertheless decide to abolish hedonic damages; nevertheless, the justification for such a policy could not be based upon the science of adaptive preferences at this time. Rather such a policy would need to be formulated on the basis of an alternative ground (e.g., economic, broad social policy, etc.).

3. THE IMPORTANCE OF UNDERSTANDING THE NATURE OF SCIENCE

> I found that jurors wanted to ask questions about scientific and medical evidence in court because lawyers hadn't asked the right questions. . . . Many lawyers have also never learnt how to present forensic evidence because they have no scientific training, despite the huge rise in the use of such evidence. . . . So people are potentially being convicted or acquitted wrongly because lawyers don't know enough about science—it's scary. (Lampathakis, 2008)

The Bagenstos and Schlanger (2007) example, some might think, is somewhat overdrawn so that the authors have selected a highly unrepresentative picture of legal engagements with science. What is concerning (though often surprising to non-legal audiences) is that this is far from a one-off. While the Bagenstos and Schlanger story concerns two legal academics making uninformed journeys into the world of science, most lawyers in the context of undergraduate training and at the level of professional training do not receive instruction in research methods or science. As such, the errors of this sort, which arise within legal academic literature, also happen in the context of the courtroom, by attorneys and judges alike:

> An impact with a car's steering wheel causes lung cancer. Breast cancer is triggered by a fall from a streetcar, a slip in a grocery store, an exploding hot-water heater, a blow from an umbrella handle, and a bump from a can of orange juice. Cancer is aggravated, if not actually caused, by lifting a forty-pound box of cheese. Everybody knows, of course, that such stories are fiction. Falls and bumps don't cause cancer. Other stories tell how a spermicide used with most barrier contraceptives cause birth defects. We know it doesn't. The whooping cough vaccine causes permanent brain damage and death. That's not true either. The swine flu vaccine caused "serum sickness." It didn't. A certain model of luxury car accelerates at random, even as frantic drivers stand on the brakes. Not so. Incompetence by obstetricians is a leading cause of cerebral palsy. It isn't. The morning-sickness drug Benedictine caused an epidemic of birth defects. It didn't. Trace environmental pollutants cause "chemically-induced AIDS." They don't. How can anybody be absolutely certain about these didn'ts, doesn'ts, and don'ts? No one can. But the science that refutes these claims is about as solid as science ever is. And yet all of these bizarre and fantastic stories . . . are drawn not from the tabloids but from legal reports. They are announced not in smudgy, badly typed cult newsletters, but in calf-bound case reports; endorsed not by starry-robed astrologers, but by black-robed judges; subscribed to not only by quacks one step ahead of the authorities but by the authorities themselves. They can be found in the dusty shelves of any major law library. The cancer-by-streetcar cases are decades old, but the others are recent. (Huber, 1993, pp. 1-2)

Speaking specifically of law, Sheila Jasanoff (1992) has noted that causal connections are seen where "most experts, at best, see only connection and try to establish responsibility for harm on the basis of data or theories that have never graced the inside of a 'mainstream' scientific text" (p 345). This highlights a problem of expertise, which, we assert, is incredibly hard to overcome. In the absence of an insight into the nature of science, lawyers, judges and policy makers will typically be dependent upon a lay conception of science, be dependent upon complete trust in science, or treat all science emerging within the courtroom as disputable facts where "all facts" are treated as "equally contingent in a forum where adversaries have every incentive to overstate the weakness in each other's positions" (Jasanoff, 1992, p. 358). As Hoffman (1995, p. 1137) argues, "members of the legal community who rely upon these studies to formulate public policy or support litigation claims . . . must learn to distinguish good science from bad" (see also Caudill, 2002). All of these critical engagements with the intersection of law and science raise serious questions as to whether lawyers, the judiciary, and indeed, policy makers are "knowledgeable" consumers of science. They raise important questions about the everyday stuff of law, whether the use of scientific evidence in policy debates, of forensic expert reports (de Keijser & Elffers, 2012), to virtually every aspect of *science* as it intersects with matters of justice and liberty. Commenting specifically of the criminal justice system, Graham and McQueen (2011) comment,

> As forensic experts, we see phylogenetic analysis increasingly being relied on in convictions by criminal courts and . . . we fear a renewed false confidence about the reliability of phylogenetic analysis to correctly reconstruct an HIV transmission history which may lead to risks of miscarriages of justice.

Yet a further issue needs to be highlighted here; while lawyers need to develop a stronger appreciation of the nature of science, those working within the field of science need a stronger appreciation of the nature of *law* (Ligertwood, 2012). While lawyers may lack the critical science literacy necessary to ask the "right" questions, the manner by which scientists providing "expert" evidence in the courtroom present "science" is also critical. Scientists too can be criticized for "exaggerating their level of confidence, venturing into realms where they possess little experience or proffering partial accounts" (Edmond, 2002, p. 59). Speaking of precisely this problem, Merz (2011) notes in the context of family law that lawyers and legal

professionals who increasingly turn to psychological and relevant empirical research are effectively moving into "new worlds," "for which a standard legal education leaves them poorly equipped" (p. 397). But conversely, social science researchers are "frequently blissfully unaware of the realities of the legal universe into which their findings may be dropped" (Merz, 2011, p. 406). As a consequence, Merz (2011) argues in such cases that "a failure to carefully reflect on the translation process itself yields misleading results, paired with a misguided sense of overconfidence in the scientific validity of those results" (p. 406).

4. CONCLUSION: UNDERSTANDING THE NATURE OF SCIENCE—MAKING SCIENCE MEANINGFUL

What the above suggests is that an important role that science communication can serve is to place non-scientists in the position of being able to distinguish not only good science from bad science, but also Golem science from normal science. If that is the case, then a science communication strategy which starts with substantive science, or attempts to persuade individuals of the benefits of science, cannot put actors into this position. That strategy risks delivering "matter" which can quickly be brought into doubt or hijacked by similar techniques of persuasion. A policy maker being presented with arguments from Bagenstos and Schlanger (2007) for example, would undoubtedly see claims founded directly on the basis of substantive science. From the perspective of basic "comprehension" there is no doubt that in respect of the specific scientific research that Bagenstos and Schlanger relied upon, the authors understood those papers; however, in the broader context of a scientific field, that conception of understanding is immediately brought into doubt; what they lacked was the more general understanding of science to make those papers meaningful.

Without an appreciation of the nature of science, judges, litigators, and policy makers alike will lack the skills required to form an appropriate judgment of the reliability of that science in the sense of judging whether it is credible/reliable or not. As such, to the extent that the legal process defers to matters of science, the legal process is susceptible to being hijacked by "junk science," and in the context of competing accounts of science, rather than assessing which best reflects reliable scientific opinion, these will be seen as having equal standing. But the argument has far broader application. In the context of endeavors designed to persuade public actors to change behavior through public health messages (for example, the dangers of smoking), without a deeper understanding of science, all science (whether good or bad) stands in equal rendering "persuasion," a technique which can be deployed for the public good or for individual corporate gain. As such, we argue that an ethically-directed scientific communication agenda should have as a baseline aspiration for that distinction to be one which can be drawn.

As such, scientific literacy or "understanding of science" should start with the grammar of science so that public actors understand the limits of not being immersed in the scientific community. In this sense, it is a rudimentary training in the theory of knowledge and expertise which delivers the skills of sociological discrimination (for more detailed discussion of sociological discrimination, see Weinel, 2007, 2012). An example here emerges from the case of Thabo Mbeki's understanding of science, which has been explored at length elsewhere (Weinel, 2007). Actors untrained in the nature of science who attempt to forge policy based upon reading "scientific literature" in isolation can only make policy-relevant technical judgments on the basis of ubiquitous discrimination. Yet an understanding of "science" as a

process—notably skills of sociological discrimination—would militate against such an approach. In such cases, actors would realize that the full scientific discourse (which includes not only published, but critically, also oral discourse) does not appear in a few randomly selected journals; moreover, such actors would appreciate the need to overcome a range of logistical problems, including difficulties in evaluating the literature, the processes entailed in discerning what is reliable or not, and the need to weigh the relative importance of the literature, including evaluation of its limitations or biases and its acceptance within the scientific community. Actors understanding the nature of science would realize that not all science is equal, and that not all science is good science. Moreover, actors would not be fooled by the seemingly "accessible" nature of some scientific papers but would realize that the language deployed can often convey far deeper meanings. Finally, actors would develop the kinds of critical reasoning tools to allow them to think and reason beyond mere trust in science toward an engagement with science that looks for key signifiers that the science being presented before them has been compiled in a way that meets the rigor that science demands of itself.

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